International Journal of Modern Electronics and Communication Engineering (IJMECE) ISSN: 2321-2152
Volume No.-7, Issue No.-3, May, 2019

Cross-correlation and Variance based Double Talk Detection for Cancellation of Acoustic Echo

Mrs. A. P. Patil , Dr. M. R. Patil

***Abstract*:** Here, we present decision rules for detection of double talk in acoustic echo cancellation. Double talk occurs when near end talk and far end talk coexist simultaneously and also degrades the voice quality in communication. This detection algorithm is implemented using three different methods so as to obtain the maximum coefficient of cross correlation using far end signal , microphone signal and variance of error signal in first method. In second method the maximum coefficient of cross-correlation using far end signal, error signal and variance of microphone signal is obtained and in third method the maximum coefficient of cross-correlation of microphone signal ,error signal and variance of far end signal is achieved. This detection of double talk is necessary to avoid the divergence of acoustic echo cancellation algorithm. The benefits of this approach are fast convergence rate , less number of computations, and very simple to implement with good echo return loss enhancement.

Keywords: Cross-correlation, Double talk, Echo Return Loss Enhancement, Variance.

.

I. INTRODUCTION

Detection of Double Talk

In full duplex communication, when talk of near end speaker and far end speaker exist simultaneously, double talk occurs which eminently degrades the performance of echo canceller. The quality of communication is very poor due to acoustic echoes. Hence in communication the echoes must be controlled. The adaptive algorithms are commonly used for detection of double talk. The updating of filter coefficients will stop when there is talk from both ends simultaneously and inherently the quality of speech will be degraded. In an application of system identification such as cancelling of echoes, the filter taps of adaptive filter are diverged by the mixing of near end speaker speech with the far end speech which causes double talk. [1]During this period the adaptive filter coefficients are freeze to zero.

The important task in echo cancellation of acoustic type is to find out instant at which the adaptation of filter must be stopped.[7,9] In presence of far end talk only the filter must be adapted and not when far end speech and near end speech occur at the same time. The speech of near end would make the system estimation process fail and produce extremely erroneous results. Hence it is difficult to find out the time instants at which near end speech and far end speech both occur and overlap with each other. The cross correlation methods are more suitable for the same.

The basic conventional Geigel algorithm is a very simple double talk detection method with less number of computations. It assumes that the power of far-end talk is lower than the power of near-end talk when we receive the signal in the microphone, so this algorithm is suitable for line echo cancellation. In Variance Impulse Response algorithm (VIRE) variance of the coefficients of adaptive filter is obtained. If the maximum variance value becomes greater than threshold, which could be varied over time, their is double-talk.[2] Also there are different technical approaches discussed for double talk detection.[8]

Frequency domain Double Talk Detection algorithm

A common basic for most DT detection schemes involves computation of a detection variable from the available data such as the near-end, far-end and/or residue error signal, and comparison of the detection variable with a preset constant value of threshold.[2] Depending on whether the detection variable is above or below the threshold, a decision is made on whether simultaneous talk from both end occur or not. If this occurs, the filter adaptation is stopped or slowed down for hold time. When the non-DT condition lasts consecutively over the hold time, the adaptation can be resumed until the next DT condition occurs.[2,3]

Any algorithm to be used for detecting simultaneous talk condition from both end must respond within no time to stop the varying of coefficients as soon as possible. The decision rule for detecting double talk is as follows:

i) D1= maximum cross-correlation coefficient > cross-correlation threshold (constant value)

ii) D2= variance>variance threshold (constant value)

iii) Double talk DT=D1.D2

If all above conditions exist the double talk is detected.

However the threshold values change for every input signal. This decision is in terms of maximum value of cross correlation using far end talk and microphone output, cross correlation using far end talk and error output, cross correlation using microphone output and error output.[4] Because of simple implementation and less number of computations the frequency domain approach is chosen.

II. METHODOLOGY

In our proposed algorithm of detecting simultaneous talk, cross correlation and variance of speeches are used. The path of echo is an unvarying impulse response. If maximum cross correlation coefficient and variance are greater than the corresponding thresholds then their is double talk. The cross correlation and variance are greater than threshold means these signals contain talk of near end and talk of far end. Hence when near end talk and far end talk occur simultaneously it detects double talk. The implementation of algorithm consists of following steps:

1. Cross-correlation coefficients of far end talk and error output are obtained.
2. With respect to near end talk variance of microphone output is obtained

3. To check if maximum cross-correlation coefficient is greater that threshold cross-correlation.
4. To check if maximum variance is greater than threshold variance
5. If above conditions in (3) & (4) are true then double talk is detected.

Above steps are implemented in first method. Similarly second method is implemented using cross-correlation coefficients of far end talk and microphone output, with variance of error output. The third method is implemented using cross-correlation coefficients of error output and microphone output, with variance of far end talk.

Method of Double Talk Detection	Echo Return Loss Enhancement in dB
Cross correlation between x and m	36
Cross correlation between m and e	32
Cross correlation between x and e	25

III. RESULTS

We have evaluated the performance of echo canceller which detects double talk using the ERLE parameter through computer simulation [5,6]. The ERLE is as below:

The above table explains the methods in short where, x is far end talk, m is microphone output and e is the error output.

Discussion

We have used the algorithm of adaptive filter in frequency domain with value of step size equal to 0.025. The recorded acoustic speech signal of 30seconds duration sampled at 8 KHz is considered as the input to the filter which is adaptive in nature. The length of adaptive filter is 160. The impulse response of echo path is also truncated to 160. The input signal used here is recorded speech of a male and a female talker. The results which are simulated obtaining the cross correlation of talk of far end and error output with variance of microphone output are discussed here.

Figure 1 shows the near end talk, talk from far end, both of these added microphone output and the final output of acoustic echo cancellation where the talk of far end is cancelled out. The cross correlation of far end talk and error output with threshold cross correlation is demonstrated in figure 2. Figure 3 shows the variance of the microphone signal with threshold variance. Figure 4 shows the comparison of threshold cross correlation and threshold variance with microphone signal for the detection of double talk. The double talk is detected if the maximum coefficient value of cross correlation is greater than cross correlation threshold and variance is greater than threshold variance. The double talk is detected twice in fig 5 when near end talk and far end talk overlap at two different instants. Similarly the other two methods of detecting double talk for cross correlation using far end talk ,microphone output and cross correlation using microphone output, error output are simulated as in fig 6 and fig 7 respectively.

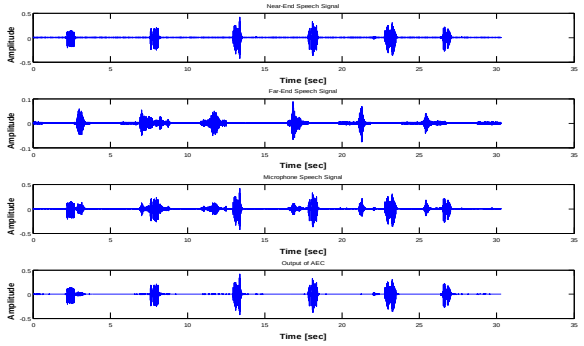

Fig 1 : Output of Acoustic Echo cancellation

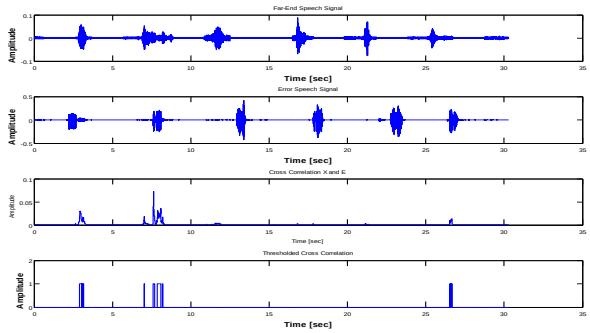

Fig 2 : Cross correlation obtained using far end talk and error output

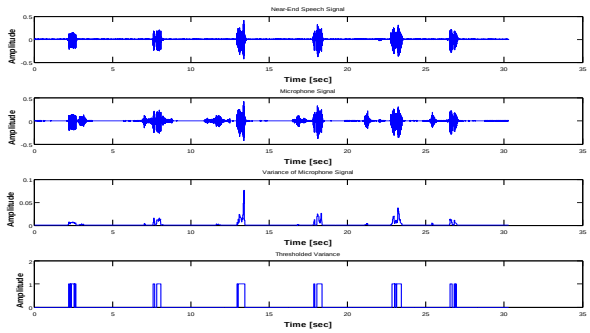

Fig 3 : Variance of Microphone signal

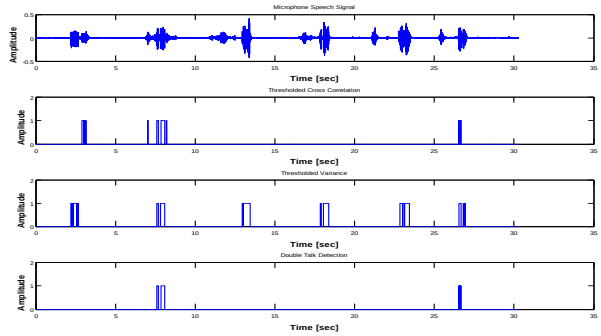

Fig 4 : Comparison of Cross correlation and Variance with microphone signal for detecting Double Talk

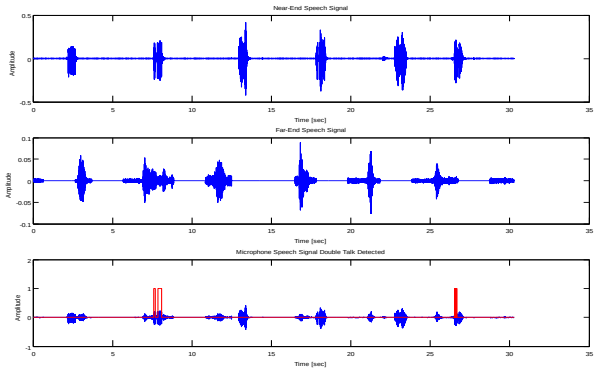

Fig 5 : Double Talk Detected when talk from near end and far end overlap

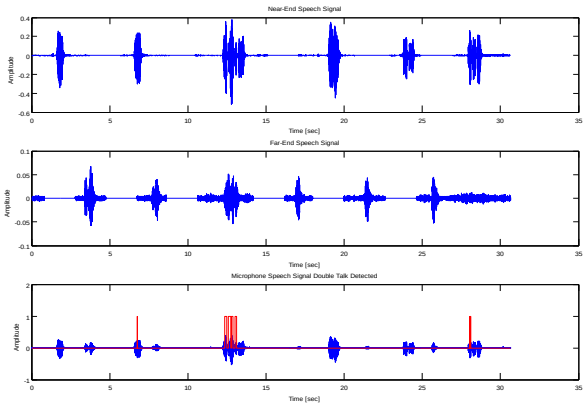

Fig 6 : Detection of Double Talk using cross correlation of far end talk and microphone output

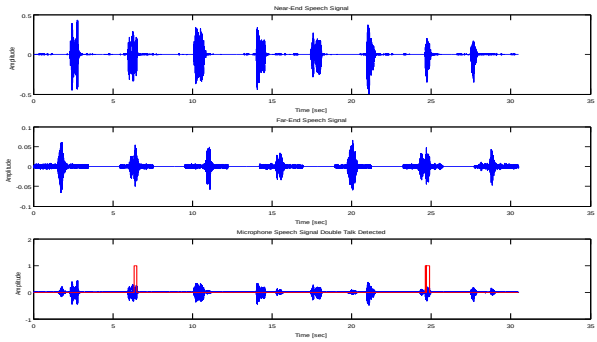

Fig 7 : Detection of Double Talk using cross correlation of microphone output and error output

IV. CONCLUSION

Finally concluding, we presented the decision rules for detection of double talk in acoustic echo cancellation. An algorithm using cross-correlation coefficient of two signals and variance of third signal has been implemented in three different ways for detection of double talk. If both cross-correlation coefficient and variance are greater than its corresponding thresholds then the double talk is detected. Furthermore the frequency domain adaptive algorithm is used for echo cancellation which has rapid convergence rate, less number of computations and robust with more simplicity. Also the performance of echo canceller with good ERLE results is achieved apart from detecting double talk.

ACKNOWLEDGEMENT

We acknowledge here for the support given by Green FM Radio Station Sangli and the acoustic input signals for this research were recorded at the same location.

REFERENCES

[1]. “Frequency Domain and Multi rate Adaptive Filtering” by John Shynk, IEEE 1992.

[2]. “J. H. Cho, D. R. Morgan, and J. Benesty, “An objective technique for evaluating doubletalk detectors in acoustic echo cancelers,” IEEE Trans. Speech Audio Process., vol. 7, no. 6, pp. 718–724, Nov. 1999.

[3]. “A New Class of Doubletalk Detectors Based on Cross-Correlation” Jacob Benesty, Member, IEEE, Dennis R. Morgan, Senior Member, IEEE, and Jun H. Cho, IEEE Transactions On Speech And Audio Processing, Vol. 8, No. 2, March 2000.

[4]. “A frequency-domain double-talk detector based on a normalized cross-correlation vector”

[5]. T. Gansler; , J. Benesty , Signal Processing 81 (2001) 1783–1787.

[6]. ”A Robust Double-Talk Detector for Acoustic Echo Cancellation” by Junghsi Lee and Hsu-Chang Huang, Proceedings of International Multi conference of Engineers and Computer scientists 2010 Vol II, Hong Kong.

[7]. ”Robust Extended Multidelay Filter and Double-Talk Detector for Acoustic Echo Cancellation” By Herbert Buchner, Jacob Benesty, Tomas Gänsler, and Walter Kellermann, , IEEE Transactions On Audio, Speech, And Language Processing, Vol. 14, No. 5, September 2006.

[8]. “Design And Simulation Of An Acoustic Echo Cancellation System For Hand-Free Telecommunication” by Ein Gyin Pwint, Su Su Yi Mon, Hla Myo Tun , International Journal Of Scientific & Technology Research Volume 4, Issue 06, June 2015.

[9]. “Advanced Adaptive Algorithms for Double Talk Detection in Echo Cancellers: A Technical Review” by Ashutosh Kar & Chandra ,Article in Advances in Intelligent Systems and Computing · January 2015.

[10]. ”Acoustic Echo Cancellation and Doubletalk Detection Using Estimated Loudspeaker Impulse Responses” by Per Åhgren IEEE Transactions On Speech And Audio Processing, Vol. 13, No. 6, November 2005.